COMPUTER MODEL FOR ESTIMATING FIELD OPERATION MANPOWER (AHTD MAN-HOUR FORECASTER USER'S MANUAL)

SP/3

MBTC FR 1026

Ron Skeith and Jerry Bullard

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The objective of this project was to design a computer model which is capable of forecasting the field manpower requirements for the Arkansas Highway and Transportation Department. In addition, the model will forecast when this field manpower is needed by each project.

The completion date of the project was 6/30/96. The project required an extension because of the complexity of the projection models. In addition, several features were developed that were not part of the original proposal. A network interface has been developed so that the required data can be entered with less effort on the part of the user.

The model was installed at AHTD on 5/9/1996.

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AHTD Man-Hour Forecaster

User's Manual

Produced for the
Arkansas Highway and Transportation Department
by the University of Arkansas
Department of Computer Systems Engineering

Dr. Ron Skeith
Jerry Bullard

Acknowledgments:

The developers of the AHTD Man-Hour Forecaster wish to thank Ralph Blackwell and David Henning of the Arkansas Highway and Transportation Department for their guidance and suggestions for the development of this product.

Blessed are the pessimists, for they shall back up often.

AHTD Man-Hour Forecaster User's Manual

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Introduction

The purpose of this manual is to describe the design, development and use of the AHTD Man-Hour Forecaster application. The AHTD Man-Hour Forecaster is a computer software package developed for the Arkansas Highway and Transportation Department by the University of Arkansas Department of Computer Systems Engineering.

The purpose of the AHTD Man-Hour Forecaster is to assist the construction engineers of the AHTD to staff the offices of the Resident Engineers throughout the State of Arkansas. It performs this function by estimating the labor required to inspect projects as they are constructed, determining when and where this labor is needed, and generating reports on this information. These reports serve as guidelines to follow when staffing the offices of the AHTD.

This project was made possible by funding from the Arkansas Highway and Transportation Department and the Mack-Blackwell Transportation Center.

Note: The AHTD Man-Hour Forecaster is a tool which *estimates* labor needs. It should be viewed as such and should not take the place of the judgment of an experienced engineer.

Getting Started

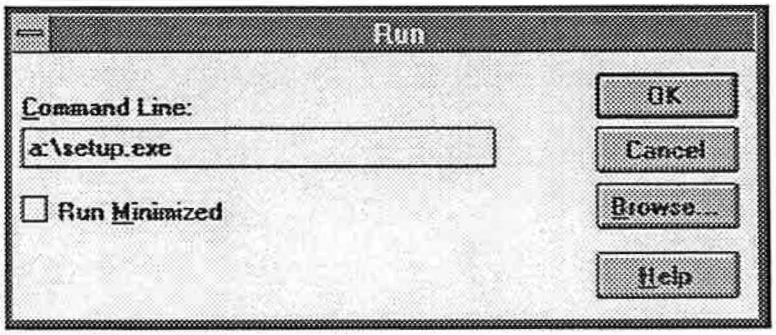
System Requirements

Before you can install the AHTD Man-Hour Forecaster, you must have certain hardware and software installed on your computer system. The minimum system requirements include:

- Windows 3.1 or later in enhanced mode.
- 80386 or higher microprocessor.
- 8 MB of RAM.
- VGA or higher resolution screen supported by Windows.
- A hard disk with a minimum of 20 MB available space.
- A 3.5-inch disk drive.
- A mouse or other pointing device supported by Windows.

Running the Setup Program

1. Insert Disk 1 into your floppy disk drive (drive A or B).
2. Start Windows and choose File | Run from the Program Manager. The window in Figure 1 will appear.
3. Type `a:\setup.exe` (or `b:\setup.exe` if your floppy is in drive B), then press ***Enter***. The setup program will start.

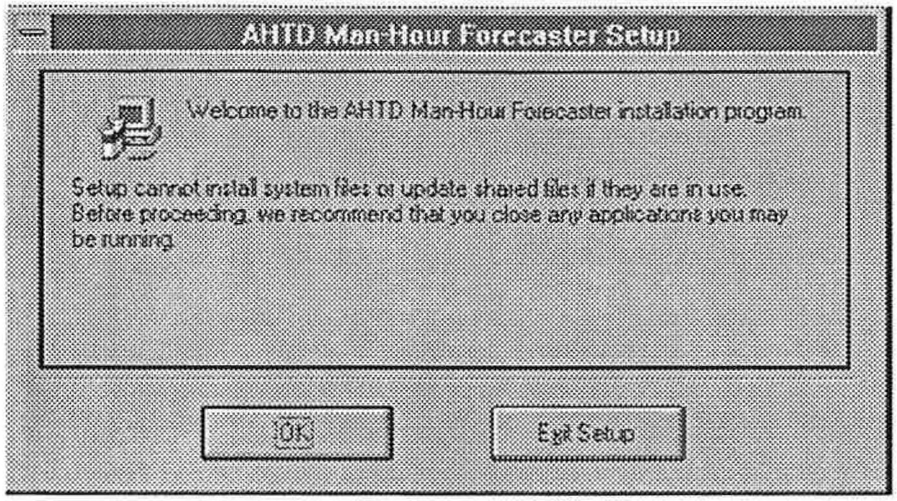


Command Line: a:\setup.exe

☐ Run Minimized

Figure 1 The File | Run window from the Windows Program Manager.

Running the Setup Program (continued)

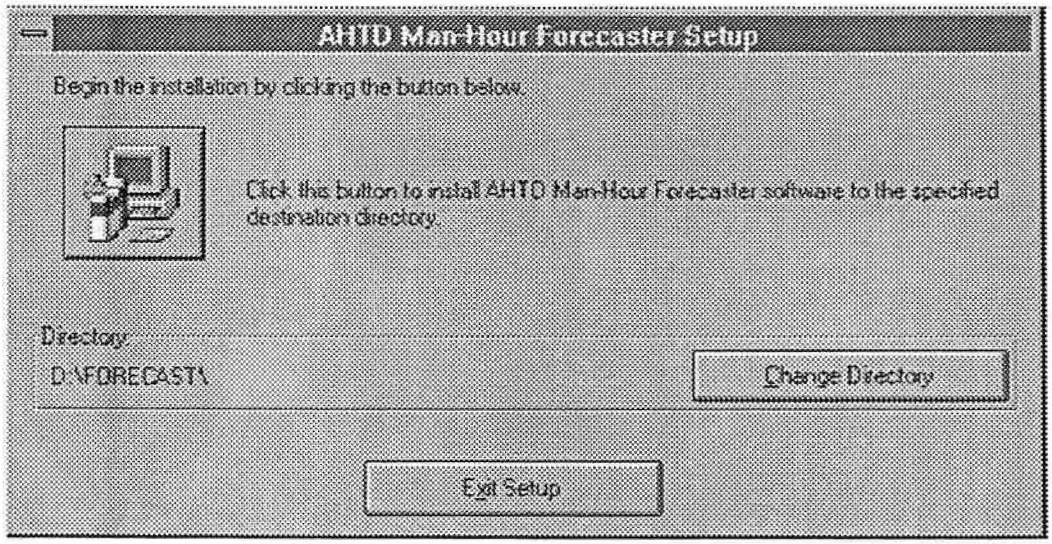


Welcome to the AHTD Man-Hour Forecaster installation program.

Setup cannot install system files or update shared files if they are in use. Before proceeding, we recommend that you close any applications you may be running.

Figure 2 The setup program's reminder window.

4. After setup has finished copying its initialization files, the window in Figure 2 appears. It reminds you to close all other applications which may be running. This is not an error message, just a reminder. Click OK to continue. The window shown in Figure 3 will then appear.



Begin the installation by clicking the button below.

Click this button to install AHTD Man-Hour Forecaster software to the specified destination directory.

Directory:
D:\FORECAST\

Figure 3 This window displays the destination directory for the program files.

5. Setup will create a disk directory in which to install the AHTD Man-Hour Forecaster's files. The default directory is `D:\FORECAST\`. To change this setting, click the Change Directory button and select a new path in the pop-up window. Click the button at the top of the window to continue.

Running the Setup Program (continued)

6. Setup will begin to install the necessary components of the AHTD Man-Hour Forecaster. This can take several minutes. When Setup prompts you for Disk 2, remove the Disk 1 from the floppy drive and insert Disk 2. Repeat this step for the other disks when Setup prompts you for them.
7. After Setup finishes installing the necessary components, it will inform you the installation is complete. Click OK to end Setup.
8. When Setup completes, close all open applications and restart Windows.

Using the AHTD Man-Hour Forecaster

Starting the AHTD Man-Hour Forecaster

During the installation process, Setup creates a group for the AHTD Man-Hour Forecaster in the Program Manager as shown in Figure 4. Double-click the AHTD Man-Hour Forecaster icon to start. The main window will appear.

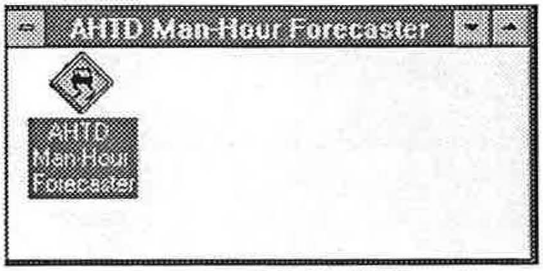

AHTD Man-Hour Forecaster
AHTD Man-Hour Forecaster

Figure 4 The program group created by Setup in the Program Manager.

The Main Window

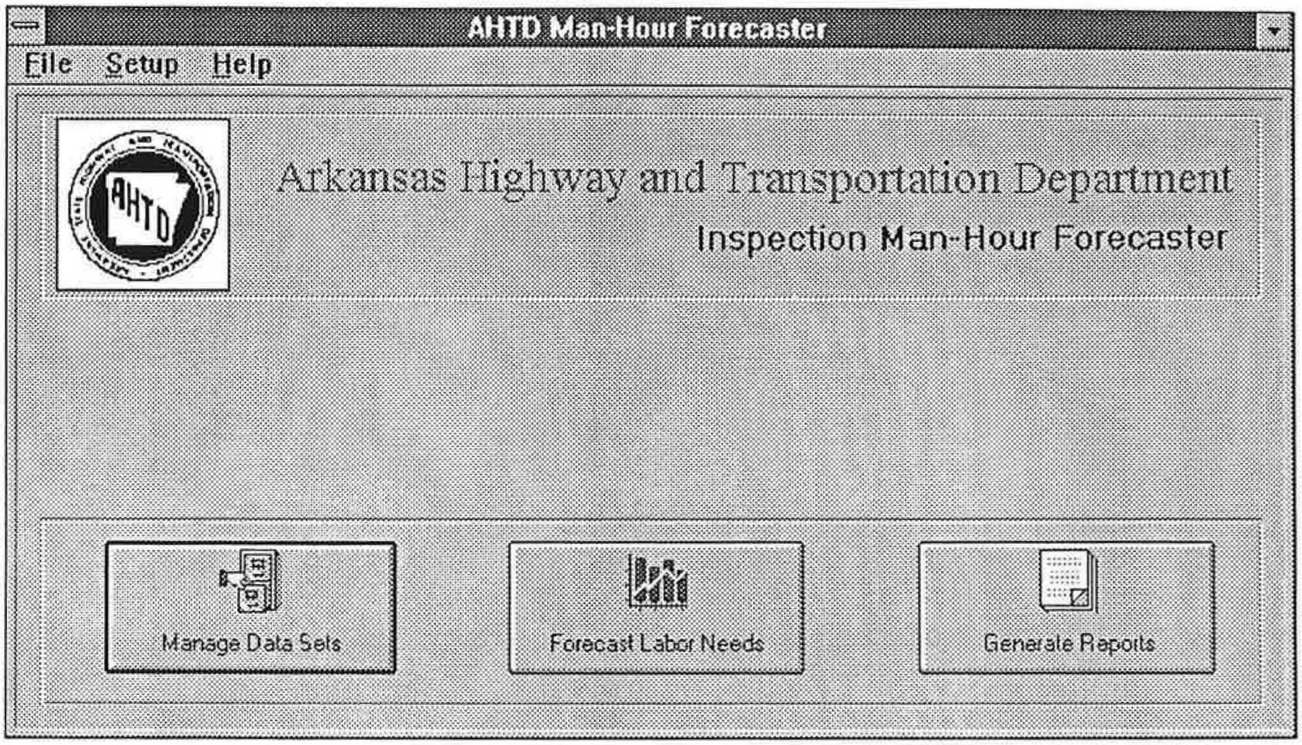

AHTD Man-Hour Forecaster
File
Setup
Help
AHTD
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Manage Data Sets
Forecast Labor Needs
Generate Reports

Figure 5 The main window of the AHTD Man-Hour Forecaster.

The main window of the AHTD Man-Hour Forecaster is shown in Figure 5. This is the main control center for the application. From here, you can set up the application's features, manage data sets, forecast labor needs, print reports, repair the database, or exit the application.

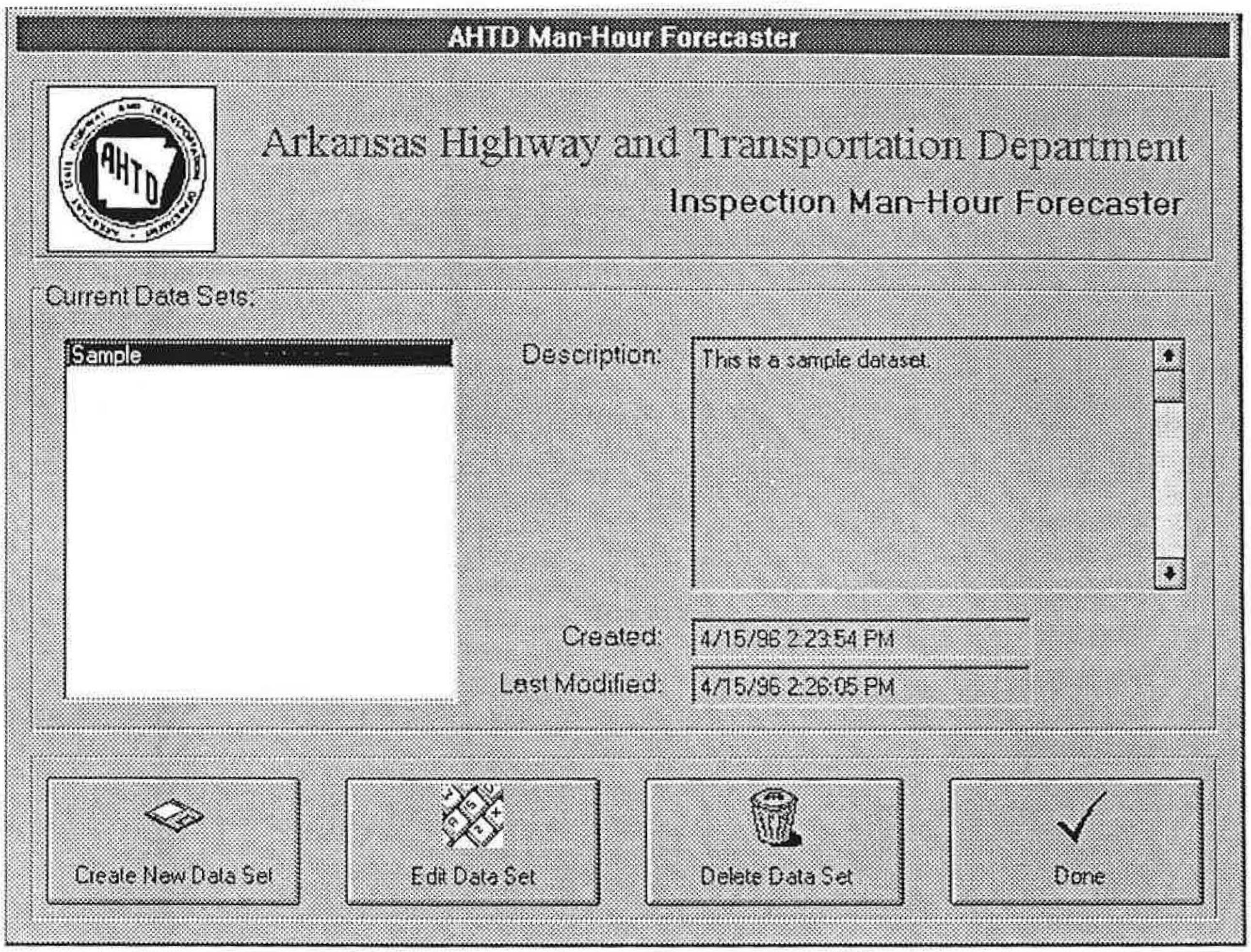
The Buttons of the Main Window

Button	Description
Manage Data Sets	Displays a window which allows you to create, edit and delete data sets. A data set is a group of jobs which are treated as a single entity for forecasting purposes.
Forecast Labor Needs	Displays a window which allows the user to perform forecasting of the labor needs of existing data sets. Each data set can have a unique forecasting period over which its man-hours will be distributed.
Generate Reports	Displays a window which allows you to print reports, either predefined reports on selected data sets or custom reports.

The Menus of the Main Window

Main Menu Item	Sub-Menu Item	Description
File	Manage Data Sets	Performs the same action as clicking the Manage Data Sets button.
	Forecast Labor Needs	Performs the same action as clicking the Forecast Labor Needs button.
	Generate Reports	Performs the same action as clicking the Generate Reports button.
	Repair the Database	Attempts to repair the database when it has been corrupted by a previous edit. This feature is only available immediately after the application starts.
	Purge Database and Load Defaults	Restores the database to its installation state. This removes all data sets from the database and resets all options and prediction equations to their defaults. This feature is only available immediately after the application starts.
	Exit	Exits the application.
Setup	Inflation Factor	Allows the user to use the inflation factor. *See Appendix F for more information.*
	Seasonal Distribution	Allows the user to specify the seasonal distribution used to spread the forecasted man-hours throughout the year. *See Appendix D for more information.*
	Underlying Trend	Allows the user to specify the coefficients of the normal distribution which is used to distribute forecasted man-hours throughout the length of a job. *See Appendix E for more information.*
Help	Contents	Displays a message directing the user to the user's manual for help.
	About	Displays information about the program, including its author, where to get assistance, and major revision number.

Managing Data Sets


AHTD Man-Hour Forecaster
AHTD
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Current Data Sets:
Create New Data Set
Edit Data Set
Delete Data Set
Done

Sample

Description: This is a sample dataset.

Created: 4/15/96 2:23:54 PM

Last Modified: 4/15/96 2:26:05 PM

Figure 6 The window displayed by clicking the Manage Data Sets button of the main window.

The Manage Data Sets Window is shown in Figure 6. This window allows you to create a new data set and modify and delete existing data sets.

The names of the data sets currently in the database are listed in the white box on the left. If you click on the name of a data set in the list, information about the data set will appear in the gray boxes to the right. As described later, you can customize this information which is stored with each data set. This allows you to name each data set and give it a description which will assist you to identify it later. The AHTD Man-Hour Forecaster automatically maintains the date and time you create and last modify a data set.

The Buttons of the Manage Data Sets Window

Button	Description
Create New Data Set	Displays the Create New Data Set window which allows the user to build a data set from a flat file. *See Creating a New Data Set which follows.*
Edit Data Set	Displays the Edit Data Set window which allows you to edit individual jobs in the data set, choose which jobs over which to forecast, and give the data set a new name and/or description. *See Editing a Data Set which follows.*
Delete Data Set	Deletes the data set which is highlighted in the list. *See Deleting a Data Set which follows.*
Done	Closes the Manage Data Sets window and returns you to the main window.

Creating a New Data Set

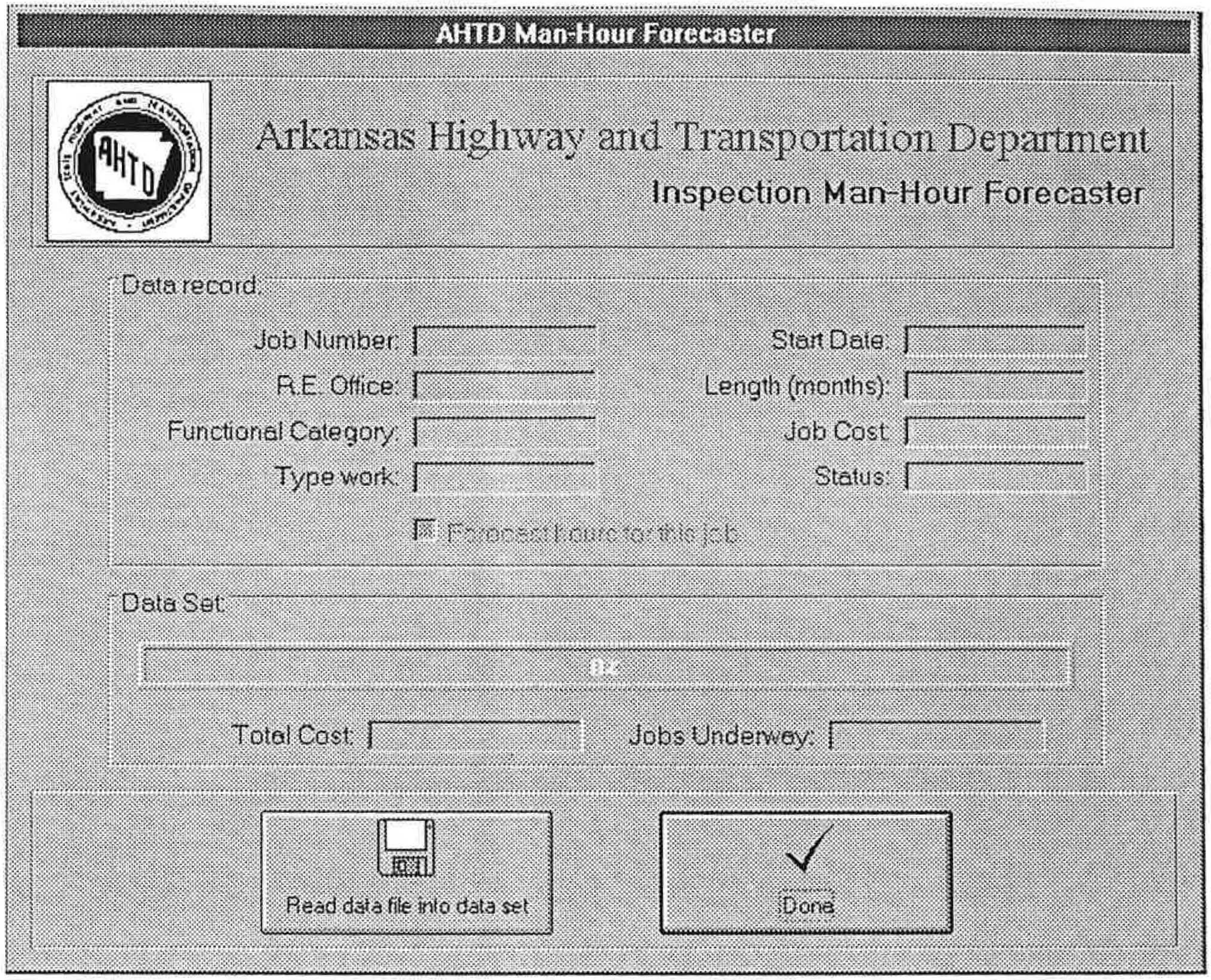
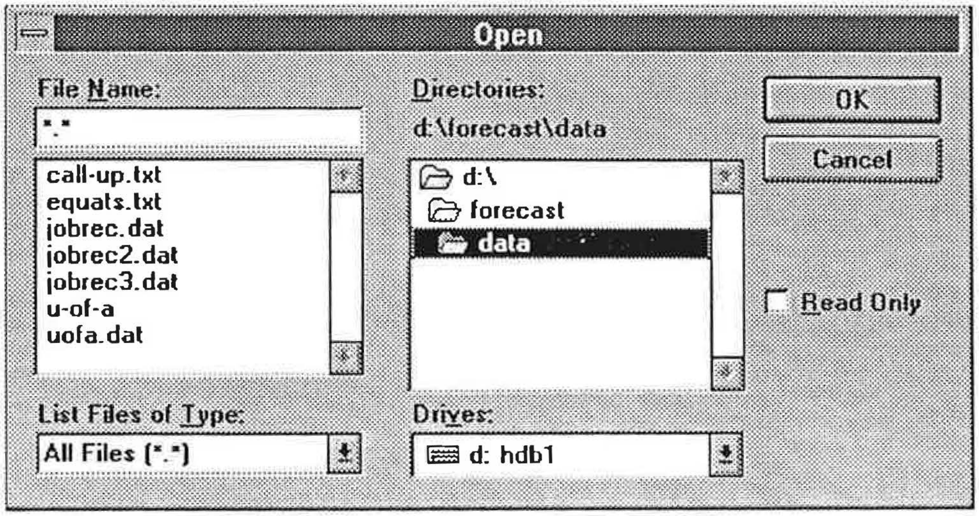

AHTD Man-Hour Forecaster
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Data record:
Job Number:
R.E. Office:
Functional Category:
Type work:
Start Date:
Length (months):
Job Cost:
Status:
☒ Forecast hours for this job
Data Set
0%
Total Cost:
Jobs Underway:
Read data file into data set
Done

Figure 7 The window displayed by clicking the Create New Data Set button of the Manage Data Sets window.

To create a new data set, use the following steps:

1. Click on the Create New Data Set button in the Manage Data Sets Window (Figure 6). The window in Figure 7 will appear. This window allows you to read into a new data set a file which contains information on projected jobs and/or jobs currently under construction. See Appendix G for a description of the format of this file.
2. To read in a data file, click on the Read Data File Into Data Set button.
3. The window shown in Figure 8 will appear.

Creating a New Data Set (continued)



Open

File Name:
.

call-up.txt
equats.txt
jobrec.dat
jobrec2.dat
jobrec3.dat
u-of-a
uofa.dat

Directories:
d:\forecast\data

d:\
forecast
data

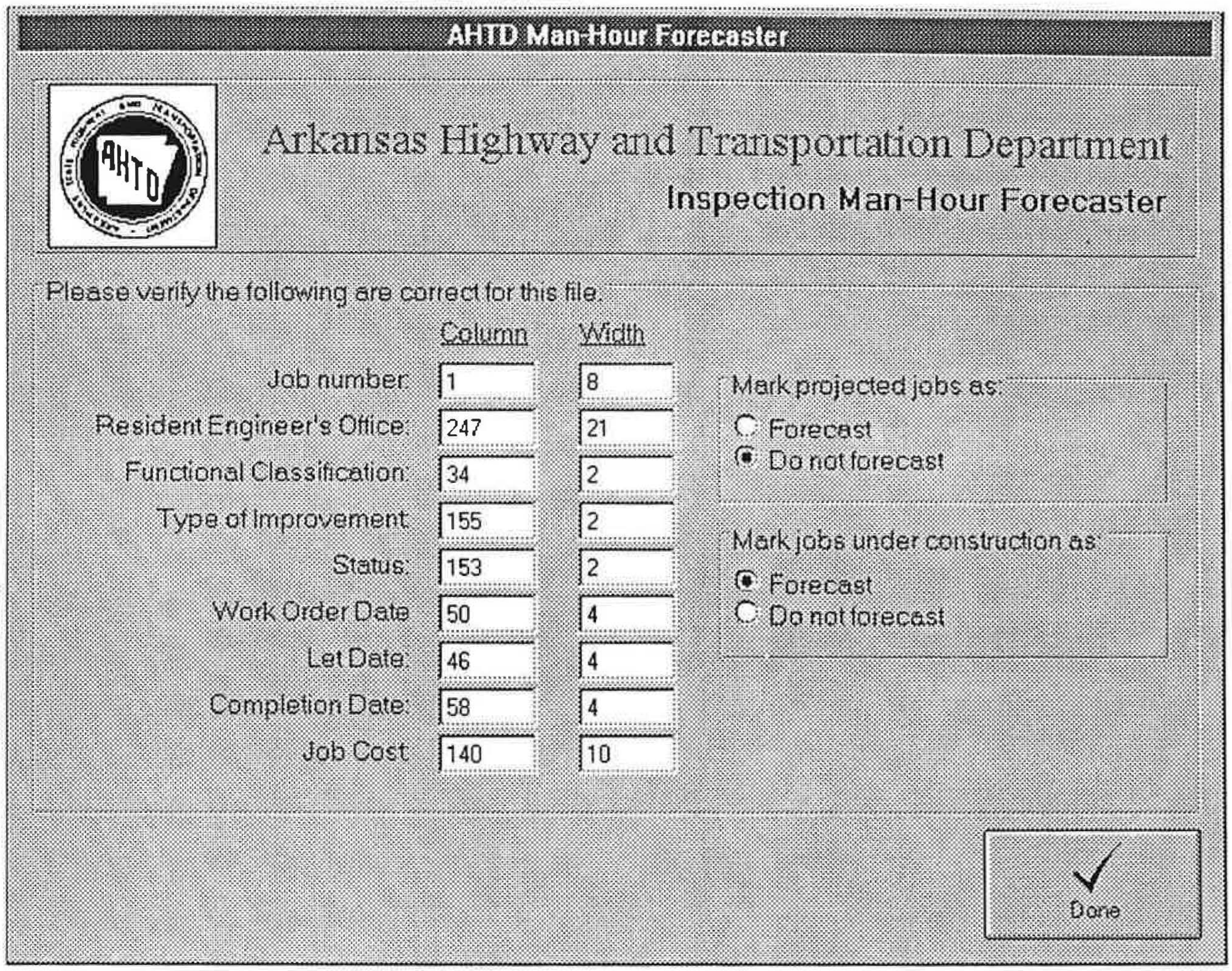
List Files of Type:
All Files (*.*)

Drives:
d: hdb1

Figure 8 The file selection window displayed by clicking the Read Data File Into Data Set button in the Create New Data Set window.

4. Select the file you wish to read into your new data set and press the OK button.
5. The window in Figure 9 will appear. This window will allow you to specify the format of the input file and whether or not you wish to forecast projected jobs and jobs under construction.

Creating a New Data Set (continued)



Arkansas Highway and Transportation Department

Inspection Man-Hour Forecaster

Please verify the following are correct for this file:

	Column	Width
Job number:	1	8
Resident Engineer's Office:	247	21
Functional Classification:	34	2
Type of Improvement:	155	2
Status:	153	2
Work Order Date:	50	4
Let Date:	46	4
Completion Date:	58	4
Job Cost:	140	10

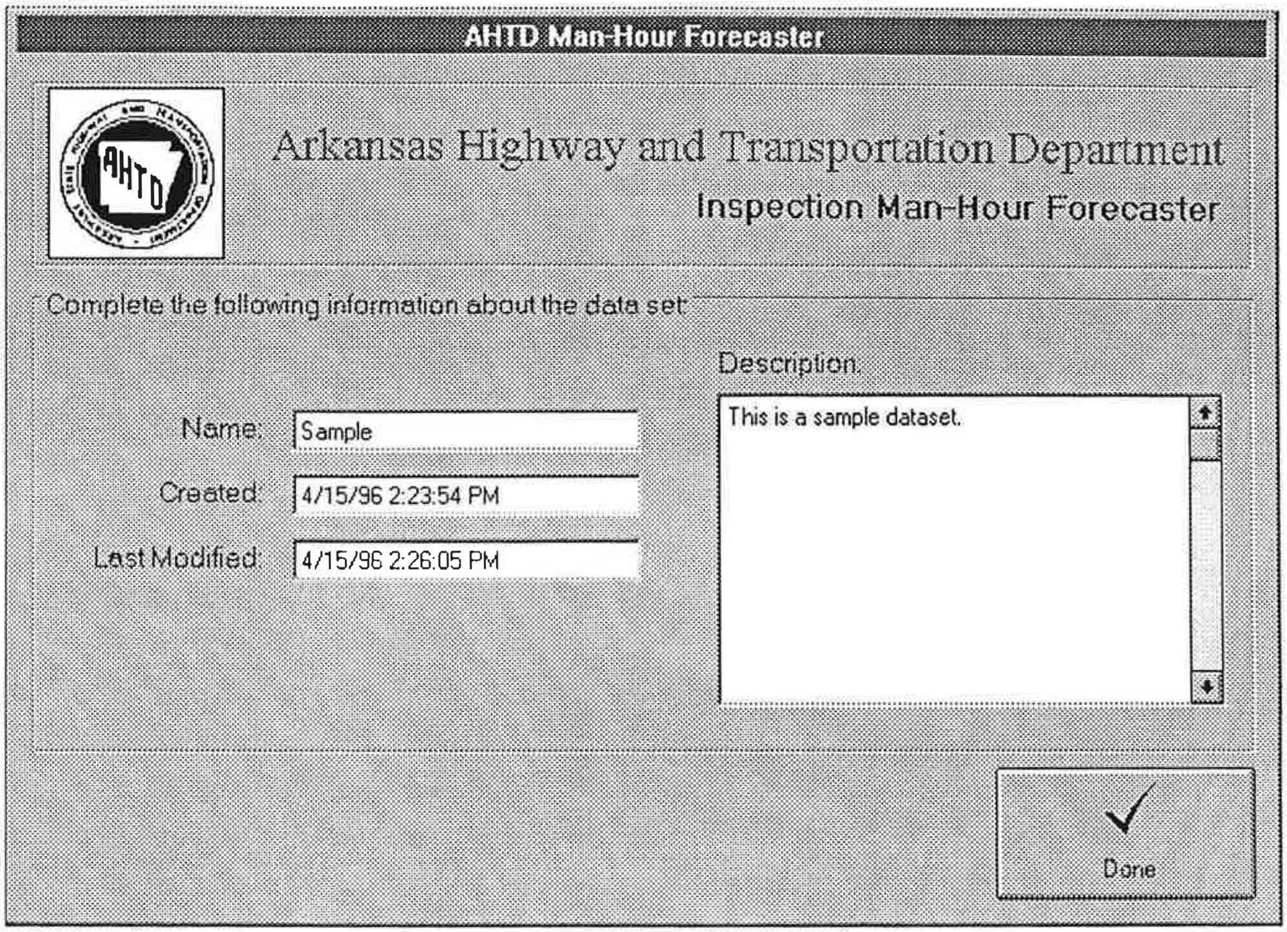
Mark projected jobs as:
○ Forecast
● Do not forecast

Mark jobs under construction as:
● Forecast
○ Do not forecast

Figure 9 The window that appears after selecting a file and clicking OK in the file selection window.

6. For each item in the list, verify the position of its column and column width in the input file. To change a value, click in the appropriate box, and use the keyboard to type the correct value. Some values such as the width of a date can not be changed. *For a more detailed description of file formats see Appendix G.*
7. Select the forecasting option for the projected jobs and jobs under construction. To change this setting click on the circle next to the option of your choice.
8. Click on the Done button to continue. The window in Figure 9 will close, leaving the Create New Data Set window (Figure 7). The program will then begin to read the data file you specified. The progress it makes is indicated by the guage in the center of the window. In addition, information on each record is displayed as it is processed, and useful information on the data set as a whole is displayed. If there is a problem with the data file, the program will notify you. If this occurs, you can cancel the operation by clicking the Done button, and check the file format before trying again.

Creating a New Data Set (continued)


AHTD Man-Hour Forecaster
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Complete the following information about the data set
Done

Name: Sample

Created: 4/15/96 2:23:54 PM

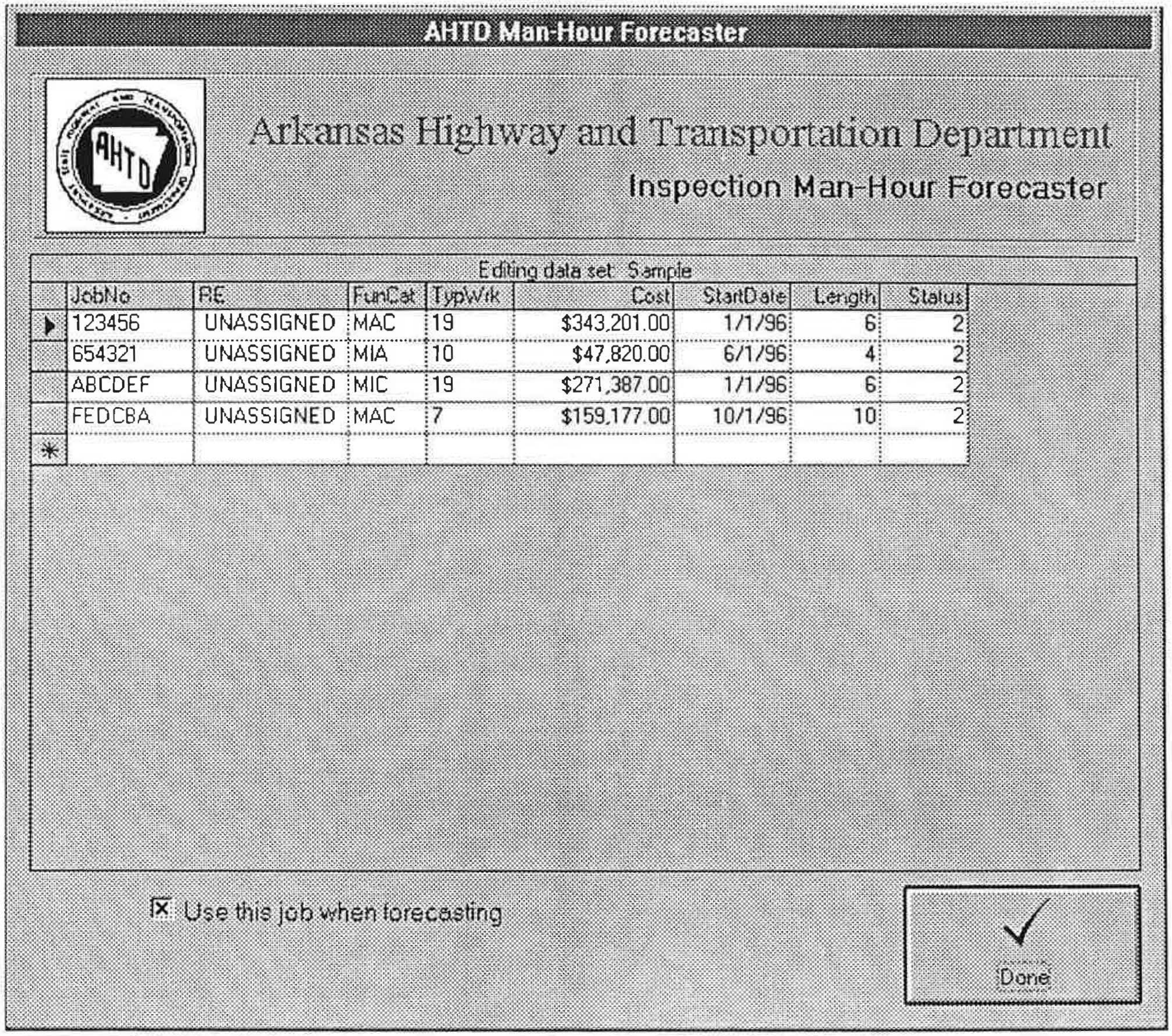
Last Modified: 4/15/96 2:26:05 PM

Description: This is a sample dataset.

Figure 10 The window displayed by clicking the Done button in the Create New Data Set window.

9. When the program has finished reading the file in the Create New Data Set window, click on the Done button. This displays the window in Figure 10. This window allows you to give the new data set a name and description.
10. Type the name and description you wish to give the new data set into the appropriate boxes. To change the text in a box, click in the box and use the keyboard to type the new text.
11. Click on the Done button to continue. This will complete the creation of the new data set and return you to the Manage Data Sets window.

Editing a Data Set


AHTD Man-Hour Forecaster
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Done

Editing data set: Sample

	JobNo	RE	FunCat	TypWrk	Cost	StartDate	Length	Status
▶	123456	UNASSIGNED	MAC	19	$343,201.00	1/1/96	6	2
	654321	UNASSIGNED	MIA	10	$47,820.00	6/1/96	4	2
	ABCDEF	UNASSIGNED	MIC	19	$271,387.00	1/1/96	6	2
	FEDCBA	UNASSIGNED	MAC	7	$159,177.00	10/1/96	10	2
*								

☒ Use this job when forecasting

Figure 11 The window displayed by clicking the Edit Data Set button in the Manage Data Sets window.

The Edit Data Sets window is shown in Figure 11. This window displays all the job records currently in the data set in a tabular format. Each row of the table, otherwise known as a job record, represents a job in the data set. If there are too many records in the data set to fit in the window, a scroll bar will appear to give access to those records which are not visible.

This window allows you to edit the information in a data set by changing or deleting an existing job records or adding new job records. The procedures for performing these tasks are outlined below.

Editing a Data Set (continued)

Editing a Job Record

To edit the information contained in an existing job record, perform the following steps:

1. Use the scroll bars (if visible) to position the record you wish to edit in the display area.
2. Click on the field in the job record you wish to edit. This places the cursor in that field.
3. Use the keyboard to edit the information in the field.
4. Click on another record to cause the changes to be saved to the database. If you have made an error in the format of the data, the application will notify you. You must correct the error to continue.

Deleting a Job Record

To delete an existing job record from the data set, perform the following steps:

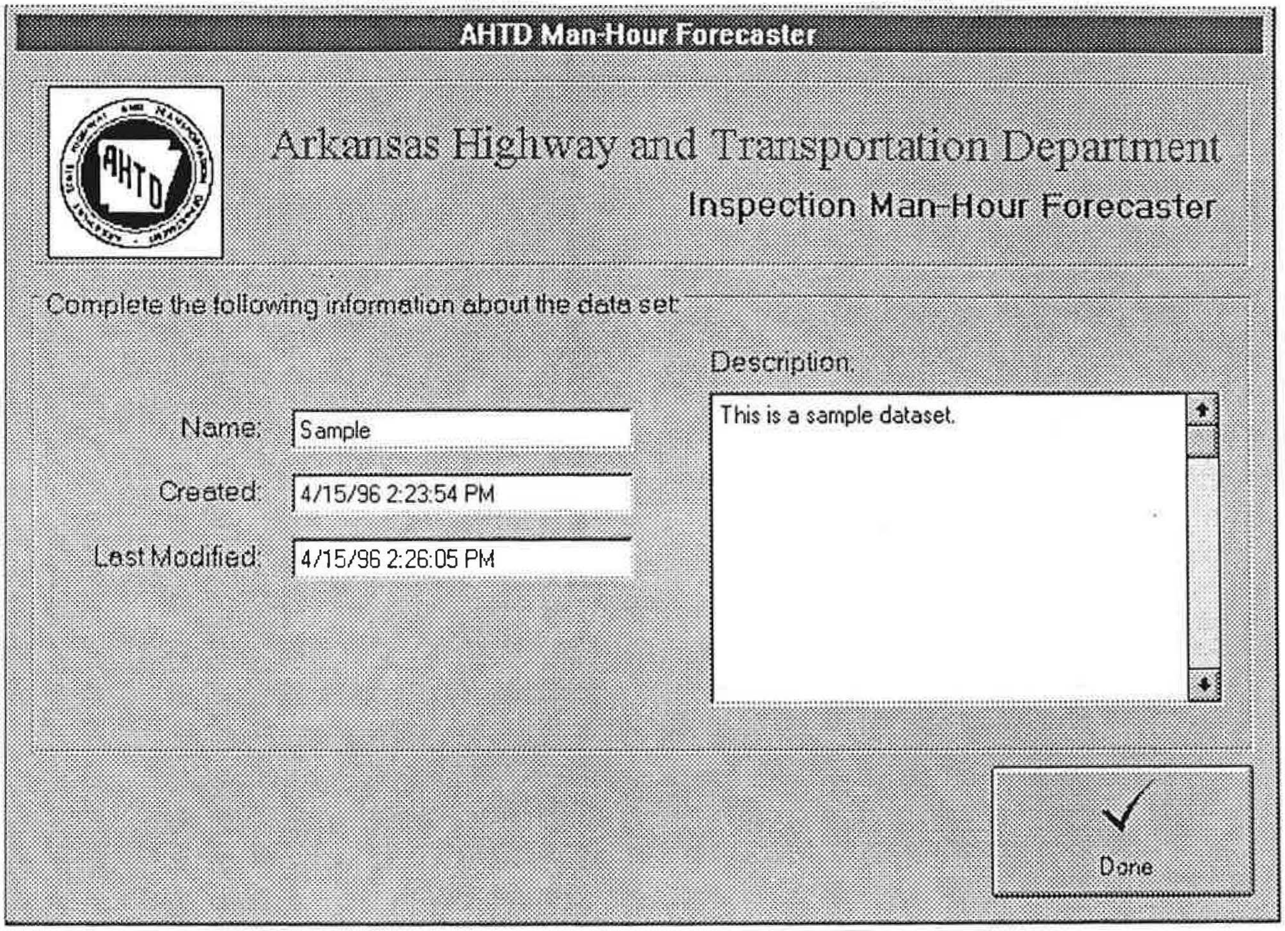
1. Use the scroll bars (if visible) to position the record you wish to delete in the display area.
2. Click on any field in the record you wish to delete. Then, click on the arrow in the leftmost column. The entire record you wish to delete should be highlighted, and a flashing cursor should be in one of the fields of the record.
3. If you are certain you wish to delete the highlighted record, press the ***Delete*** key on your keyboard. The record will be permanently removed from the data set.

Adding a New Job Record

To add a new job record to the data set, perform the following steps:

1. Use the scroll bars (if visible) to view the last record in the data set. Below the last record is an empty record with an asterisk (*). Click on a field in the empty record and begin typing a value to add a record.
2. Fill in the remaining fields in the new record. To move between fields, you can use either the mouse to click on the destination field or the keyboard arrow keys to position the cursor in the destination field.
3. After you have filled each field in the new job record, click on another record (even the empty one) to save the new record to the database. If you have made an error in the format of the data, the application will notify you. You must correct the error to continue.

Editing a Data Set (continued)


AHTD Man-Hour Forecaster
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Done

Complete the following information about the data set

Name: Sample

Created: 4/15/96 2:23:54 PM

Last Modified: 4/15/96 2:26:05 PM

Description: This is a sample dataset.

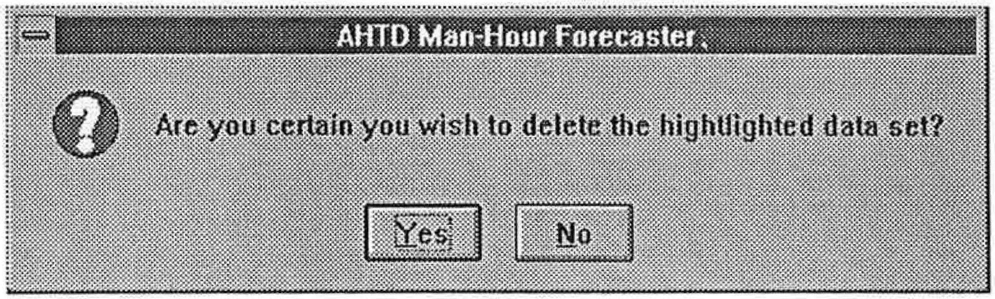
Figure 12 The window displayed by clicking the Done button in the Edit Data Set window.

When you have completed editing the data set, click the Done button. The window in Figure 12 will appear.

If you wish to change the name or description of the data set you are editing, type the new information into the appropriate boxes. To change the text in a box, click in the box and use the keyboard to type the new text. You can not change the Created and Last Modified fields, for these are updated automatically.

Click on the Done button to continue. This returns you to the Manage Data Sets window.

Deleting a Data Set



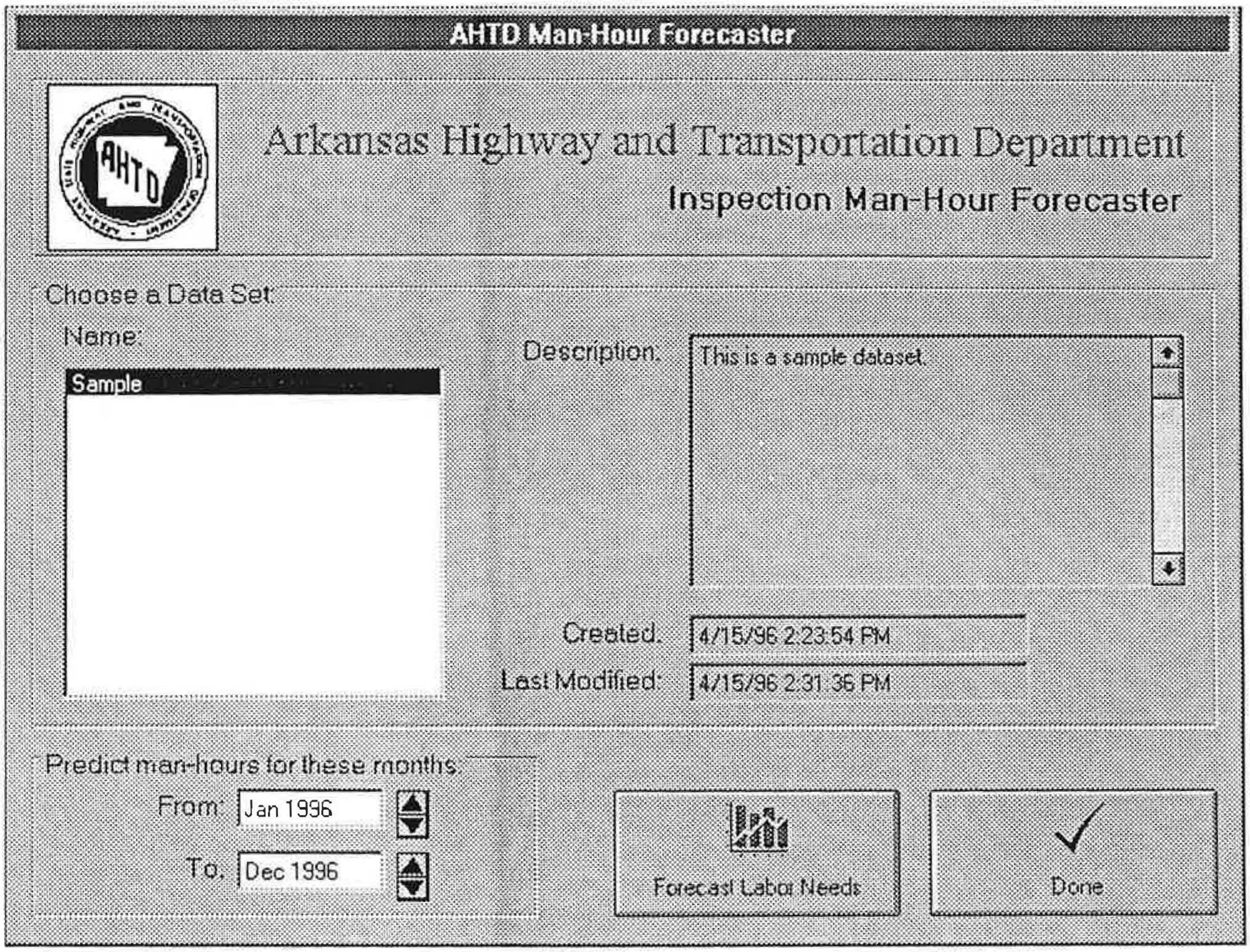
Are you certain you wish to delete the highlighted data set?

Figure 13 The warning message displayed by clicking the Delete Data Set button in the Manage Data Sets window.

The following steps enable you to delete a data set:

1. In the main window, click on the Manage Data Sets button. This displays the Manage Data Sets window (Figure 6).
2. In the Manage Data Sets window, highlight the name of the data set you wish to delete in the list of available data sets by clicking on its name.
3. Click the Delete Data Set button. The window in Figure 13 will appear.
4. If you are certain you wish to delete the highlighted data set click on the Yes button. You can cancel the operation by clicking on the No button.

Forecasting Labor Needs


AHTD Man-Hour Forecaster
Arkansas Highway and Transportation Department
Inspection Man-Hour Forecaster
Choose a Data Set
Predict man-hours for these months:
Forecast Labor Needs
Done

Name: Sample

Description: This is a sample dataset.

Created: 4/15/96 2:23:54 PM

Last Modified: 4/15/96 2:31:36 PM

From: Jan 1996

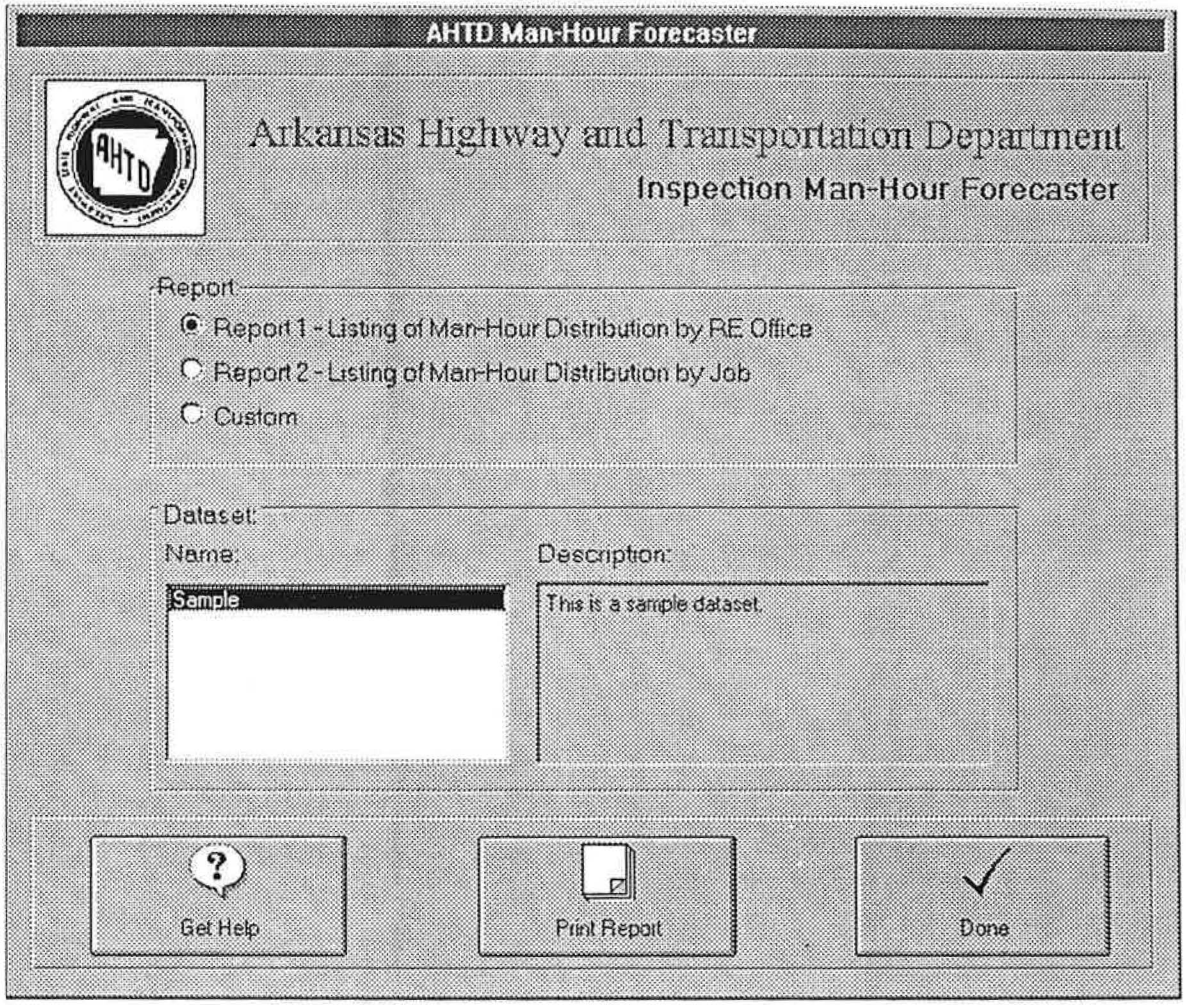
To: Dec 1996

Figure 14 The window displayed by clicking the Forecast Labor Needs button in the main window.

To forecast the labor needs of a data set, perform the following steps:

1. Create a data set which contains jobs over which you wish to forecast. *See Creating a New Data Set for more information.*
2. In the main window, click on the Forecast Labor Needs button. The window in Figure 14 will appear.
3. Select the data set over which to forecast man-hour usage. To select a data set, click on its name in the list of available data sets.
4. Specify the months you wish to include in the forecast of man-hour usage. You can change the month values by one of the two following ways: either you can click on the up and down arrows next to the month, or you can click in the box you wish to change and use the up and down arrow keys on the keyboard to change the values in the box.

Generating Reports



AHTD Man-Hour Forecaster

Arkansas Highway and Transportation Department

Inspection Man-Hour Forecaster

Report

● Report 1 - Listing of Man-Hour Distribution by RE Office

○ Report 2 - Listing of Man-Hour Distribution by Job

○ Custom

Dataset:

Name: Sample

Description: This is a sample dataset.

Figure 16 The window displayed by clicking the Generate Reports button in the main window.

After creating a data set and forecasting its labor needs, you can generate reports on its labor needs. The window shown in Figure 16 enables you to choose a reporting option and a data set on which to report.

To print a report, perform the following steps:

1. Create a data set which contains jobs over which you wish to forecast. *See Creating a New Data Set for more information.*
2. Forecast the labor needs of this data set. *See Forecasting Labor Needs for more information.*
3. In the main window, click on the Generate Reports button. The window in Figure 16 will appear.

Generating Reports (Continued)

4. Select the report you wish to run by clicking on the circle next to the name of the report.

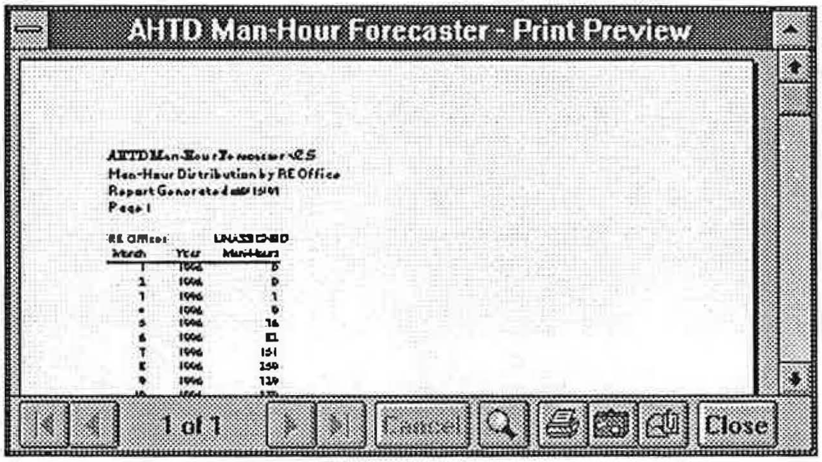


Figure 17 The window displayed by clicking the Print Report button in the Generate Reports window.

5. Select the data set on which you wish to generate a report by clicking on its name in the list.
6. Press the Print Report button. The window in Figure 17 will appear. This operation can take from a few seconds to several minutes both before and after the window appears, depending on the complexity of the report and the number of records in the database.
7. Use the scroll bars and page selection buttons (the arrow buttons in the lower left corner of the window) to review the document to be certain you are satisfied with the results. If you are not, click on the close button and correct any problems by editing the data set and forecasting its labor needs again.
8. Click the Print button (the button with the printer icon) to send the document to the printer.

Appendix A — Troubleshooting

Problem or Error Message	Probable Cause	Possible Solution
Not enough memory for operation	The application ran out of memory while performing an operation.	Close all other applications, including network software, before running AHTD Man-Hour Forecaster.
Error message displayed when trying to repair database	The database is already open, either by another application or by another part of the AHTD Man-Hour Forecaster.	Close all applications, including the AHTD Man-Hour Forecaster, and restart the AHTD Man-Hour Forecaster. Then, repair the database before performing any other operation.
Incorrect file format	The file you were attempting to read was not in the proper format, or you made an error in specifying one or more column positions and/or column widths.	Check the file format and try again. *See Appendix G for more information.*
Default equation not found	The default equation (functional category DEF) was not found in the database.	Reinstall the application, or add a default equation to the *funcat_equats* table of the database using Microsoft Access.
Can not delete because referential integrity would be violated	An error has been encountered in the database while deleting a data set	Restart the application and immediately repair the database before attempting to delete again
Other problems not listed	The database may be corrupted. The application may be corrupted.	Exit the application, restart it, and immediately repair the database before performing any other operation. Back up the files of the program to a separate directory. Then, reinstall the application.

Other Problems

If you have a problem you are unable to resolve using the above table, you can contact the developers of the AHTD Man-Hour Forecaster, Dr. Ron Skeith and Jerry Bullard.

At the time of this writing, Dr. Skeith is Head of Computer Systems Engineering at the University of Arkansas at Fayetteville, and Mr. Bullard is a graduate student in that department. To reach Dr. Skeith or Mr. Bullard, contact the departmental office at 313 Engineering Hall, Fayetteville, Arkansas, 72701, (501) 575-6036.

Appendix B — Updating the Man-Hour Prediction Equations

In order to forecast the labor needs of jobs, a set of man-hour prediction equations were developed and included in the AHTD Man-Hour Forecaster software. These equations relate the total cost of a job to its required inspection man-hours based on the functional classification and type of improvement of the job.

When you build a data set, the AHTD Man-Hour Forecaster forecasts the total man-hours for each job in the data set. First, it selects an appropriate man-hour prediction equation based on the job's type of improvement and functional classification. The total cost of the job is then entered into the equation to produce the forecasted man-hours.

When developing the man-hour prediction equations, it became necessary to categorize jobs by their functional classification. A simple categorization was chosen based on the functional classification as shown in the following table:

Road Type	Functional Category	Functional Classification				
Interstates	INT	01	11	21	31	41
Other Freeways and Expressways	OFE	-	12	22	32	42
Other Principle Arterials	OPA	02	14	24	34	44
Minor Arterials	MIA	06	16	26	36	46
Collectors Streets	COL	-	17	27	37	47
Major Collectors	MAC	07	-	-	-	-
Minor Collectors	MIC	08	-	-	-	-
Local Roads	LOC	09	19	29	39	49

The default equations were developed using the procedure shown in Figure 19. To create new equations and use them in the AHTD Man-Hour Forecaster, perform the following steps:

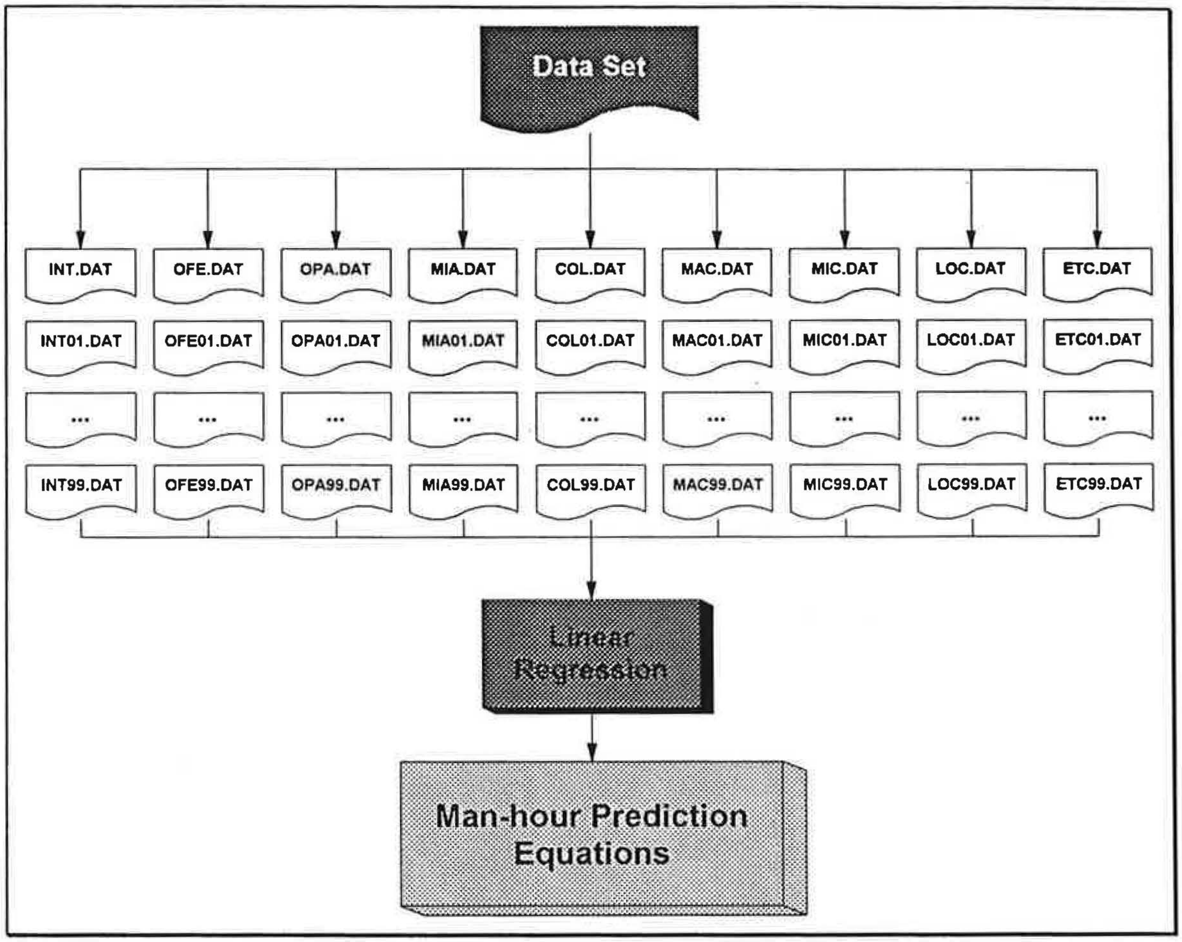

Data Set
INT.DAT
OFE.DAT
OPA.DAT
MIA.DAT
COL.DAT
MAC.DAT
MIC.DAT
LOC.DAT
ETC.DAT
INT01.DAT
OFE01.DAT
OPA01.DAT
MIA01.DAT
COL01.DAT
MAC01.DAT
MIC01.DAT
LOC01.DAT
ETC01.DAT
...
INT99.DAT
OFE99.DAT
OPA99.DAT
MIA99.DAT
COL99.DAT
MAC99.DAT
MIC99.DAT
LOC99.DAT
ETC99.DAT
Linear Regression
Man-hour Prediction Equations

Figure 18 The procedure to find the man-hour prediction equations.

1. Create a data file, referred to as a data set, which contains the total cost, total inspection man-hours, functional classification, type of improvement, and completion time for a large number of completed jobs. This data file can be of any format you choose, but it must be readable by your statistical software package.
2. Partition this large data set into separate data sets for each functional category, also keeping the original data set for further use. (Refer to Figure 18 for an illustration of this process.)
3. Further partition the data sets for each functional category into data sets for each combination of functional classification and type of improvement.
4. Compare the total cost of the jobs to their total *inspection* man-hour usage for each data set, including the original (large) data set and the various functional category data sets. Use linear regression to determine the mathematical relationship for each data set

between the total cost and length (in months) of the jobs. This step requires use of a statistical analysis software package, which is not provided.

5. Accept or reject the equations produced by the linear regressions for each data set based on the strength of the correlation (r-squared value) between the total cost and length (in months) of jobs.
6. The new job length prediction equations are the accepted equations for the data sets, the accepted equations from the functional category data sets, and the overall default equation from the original (large) data set.

To update the AHTD Man-Hour Forecaster to use these equations, perform the following steps:

1. Using Microsoft Access or other program which reads and writes Access 2.0 databases, open the **forecast.mdb** database, found in the installation directory of the AHTD Man-Hour Forecaster. The prediction equations in the database are separated into two tables, the *funcat_equats* table and the *funcat_typwrk_equats* table. The *funcat_typwrk_equats* table contains the equations from the data sets which were partitioned according to functional category and type of improvement. The *funcat_equats* table contains the equations from the data sets partitioned only by functional category and serve as defaults for each functional category when an appropriate equation can not be found in the *funcat_typwrk_equats* table. The *funcat_equats* table also contains the default equation (*funcat* = DEF) for the original (large) data set above.
2. Add, delete, or edit records in these tables to reflect the new equation coefficients. Note: You must have a default (DEF) equation in the *funcat_equats* table, which is the equation for the original (large) data set above.

Appendix C — Updating the Job Length Prediction Equations

Once the AHTD Man-Hour Forecaster has estimated the man-hours required to inspect a job, it must then distribute those man-hours over the months the job is active. However, in most cases, the job records in the data files provided by the computer center of the AHTD have a start date but not a completion date. That is why the ability to estimate the length of a job in months was integrated into the AHTD Man-Hour Forecaster and is automatic and transparent (see the Notes in Appendix G for more information).

The method used to forecast the length of a job is similar to the method employed to forecast labor needs (see Appendix B). Based on the job's functional category, a prediction equation is selected. The total cost of the job is then entered into the equation to produce the forecasted length.

Note: Forecasting the job length is the weakest link in the AHTD Man-Hour Forecaster chain. The correlation between the cost of a job and the length of a job was not as strong as was found when producing the man-hour prediction equations, especially for very large jobs. Therefore, it is imperative the job lengths be checked carefully by an experienced engineer.

The default equations were developed using the procedure shown in Figure 19. To create new equations and use them in the AHTD Man-Hour Forecaster, perform the following steps:

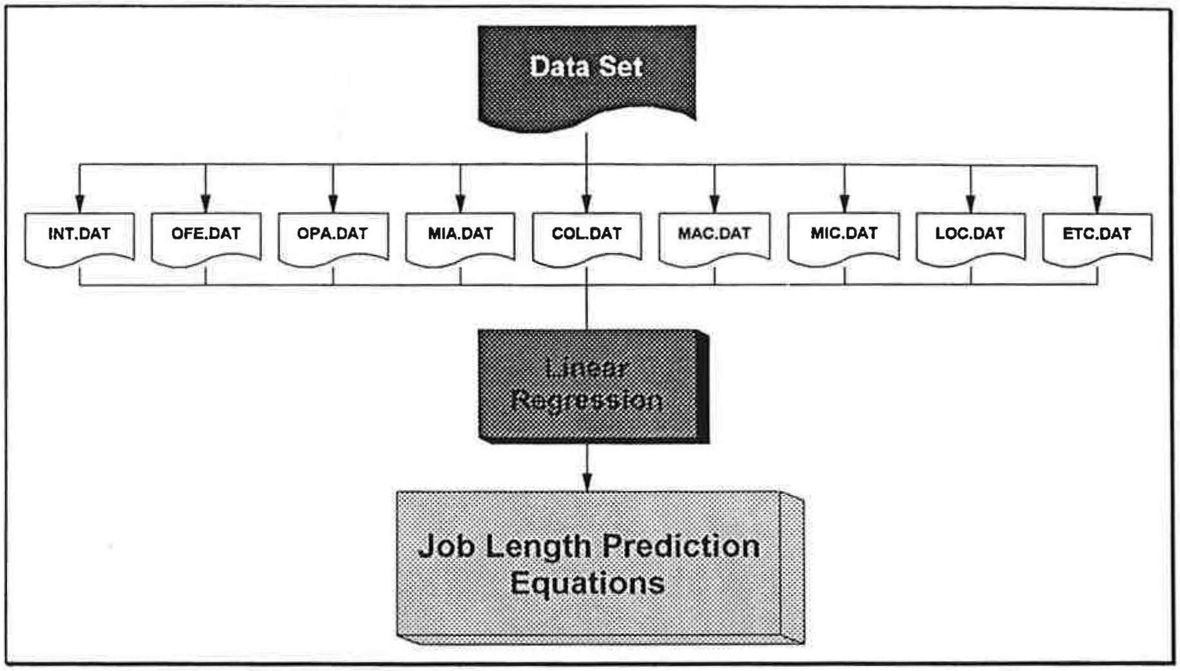


Figure 19 The procedure to find job length prediction equations.

1. Create a data file, referred to as a data set, which contains the total cost, total man-hours, functional classification, type of improvement, and completion time for a large number of completed jobs. (See Appendix B for more information on this data set.)
2. Partition this large data set into separate data sets for each functional category, also keeping the original data set for further use.
3. For each data set compare the total cost of jobs to their length (in months), including the original (large) data set. Use linear regression to determine the mathematical relationship for each data set between the total cost and length of the jobs.
4. Accept or reject the equations for the functional category data sets, produced by the linear regressions, based on the strength of the correlation (r-squared value) between the total cost and length of a job.
5. The accepted equations for the functional categories and the default equations from the original data set are the new job length prediction equations. To update the AHTD Man-Hour Forecaster to use these equations, open the *length_equats* table in the **forecast.mdb** database, found in the installation directory of the AHTD Man-Hour Forecaster. Add, delete, or edit records to reflect the new equation coefficients. Note: You must have a default (DEF) equation, which is the equation for the original (large) data set above.

Appendix D — Updating the Seasonal Distribution

The seasonal distribution is used by the AHTD Man-Hour Forecaster to spread the predicted man-hours throughout the year, taking into consideration the seasonal variances in the labor usage of the Arkansas Highway and Transportation Department. Analysis of historical man-hour usage data for the AHTD showed a correlation between the time of year and the total inspection man-hours which were performed across the state.

Figure 20 shows the historical man-hour distribution which was used to determine the default seasonal distribution. Since the distribution used was an average over several years, and since the relative distribution is not likely to change significantly, the default seasonal distribution should serve the AHTD well for the foreseeable future. However, if the seasonal variances in the labor distribution which are forecasted by the AHTD Man-Hour Forecaster are consistently incorrect, you need to examine the current seasonal

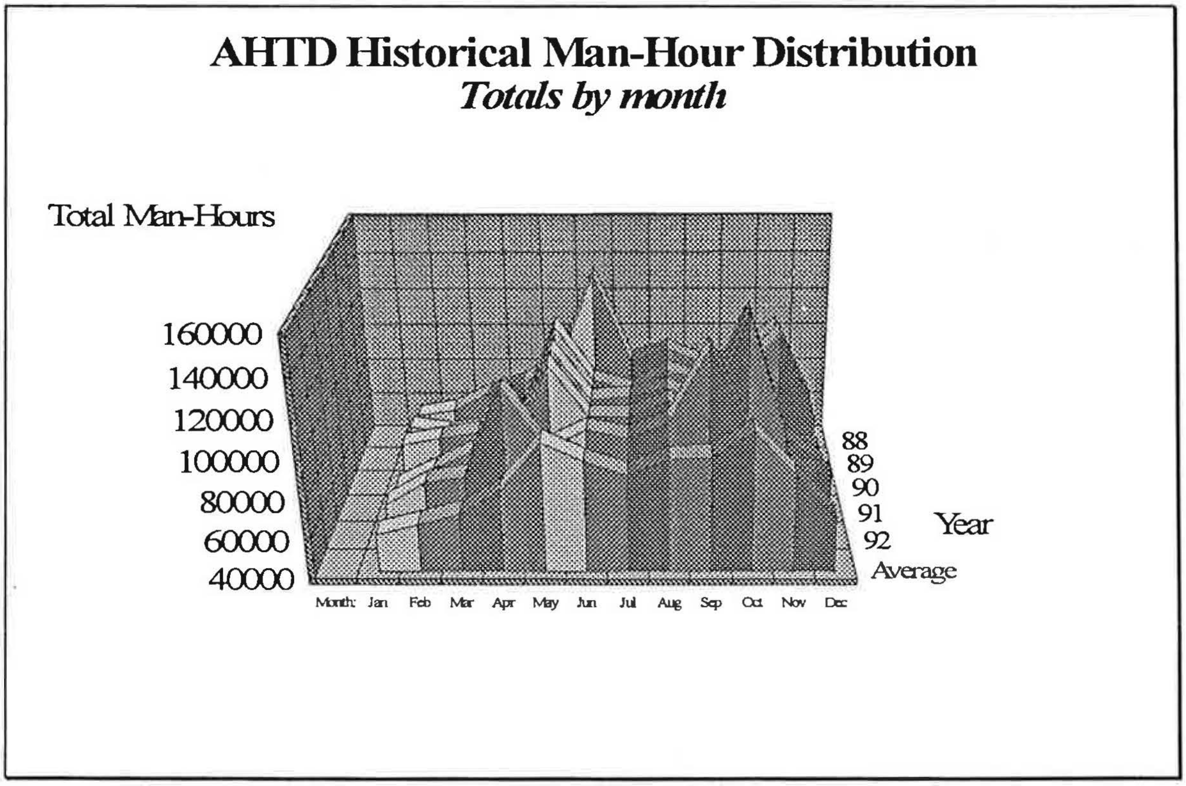


Figure 20 AHTD Historical man-hour distribution by month for the years 1988 - 1992.

Appendix E — Updating the Underlying Trend

The underlying trend is used by the AHTD Man-Hour Forecaster to distribute labor usage during the construction time of a job. Analysis of the historical man-hour usage by the AHTD showed a distinct correlation between the fraction of total job completion time and the relative man-hour usage.

The normal distribution approximates this relationship, which can be seen in Figure 22. The AHTD Man-Hour Forecaster requires only the following two values to fully and uniquely specify the normal distribution to be used to distribute the forecasted man-hours: the mean, μ (mu), and the standard deviation, σ (sigma). Mu is the mean or the center of the distribution, around which the man-hours will be symmetrically distributed. Sigma is the standard deviation of the distribution and specifies the "width" of the distribution, or how widely the man-hours will be distributed. The mu and sigma values are specified in

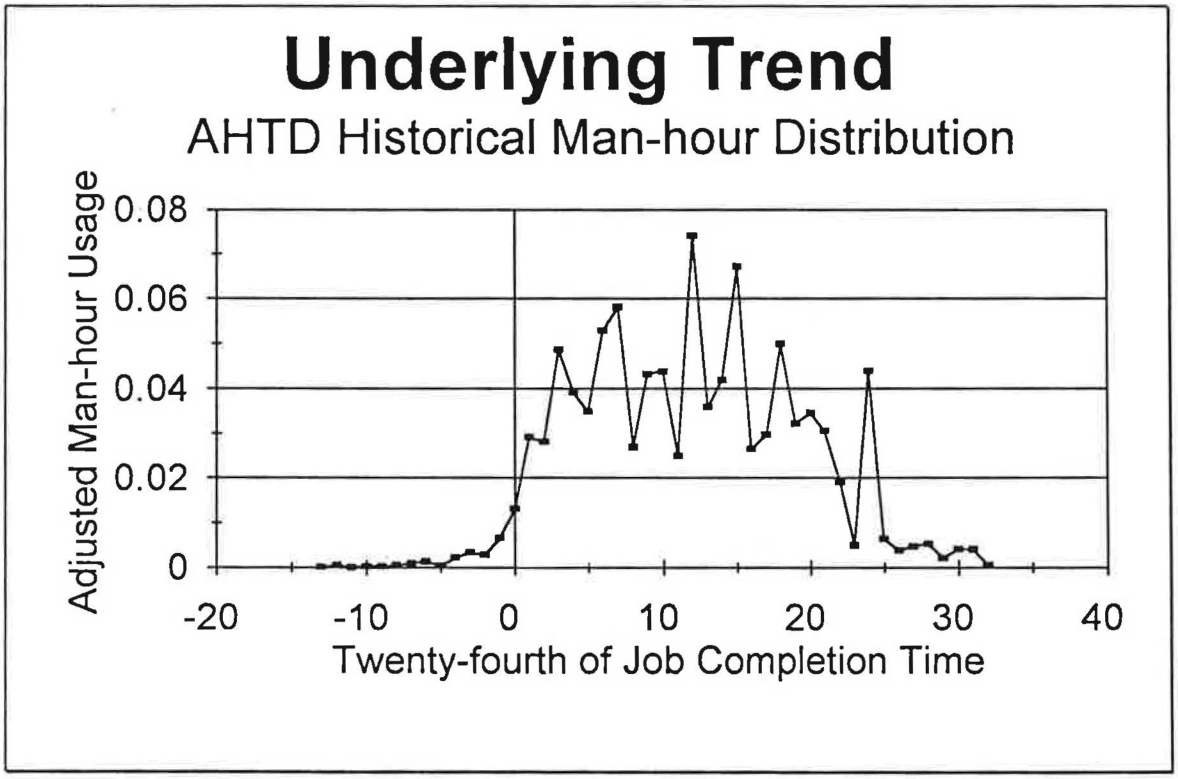


Figure 22 The AHTD's historical underlying trend in labor usage during construction of jobs.

7. Click on the Done button to save your changes.

Note: The inflation factor affects only those data sets which are created while the inflation factor is in effect. That is, selecting "Use inflation factor" will *not* affect data sets currently in the database.

Appendix G — Input File Format

The following is a list of the fields which are required in the input file when creating a new data set (see Creating a New Data Set, above). The column positions and widths shown are the default values and can be changed to suit your needs.

Title	Column / Width	Format	Description
Job Number	1 / 8	Any combination of displayable characters	The job number uniquely identifies each job. Multiple instances of a job number are allowed, but should be avoided.
Resident Engineer's Office	247 / 21	Any combination of displayable characters	This field is used to group jobs by their resident engineer (RE) for staffing the RE offices. If this field is blank, it is given the value "UNASSIGNED".
Functional Classification	34 / 2*	Two digits (0-9)	This field specifies the functional classification of the job and is used in the selection of the appropriate man-hour prediction equation. *See Functional Classification section below.*
Type or Improvement	155 / 2*	Two digits (0-9)	This field specifies the type of work being performed by the job and is used in the selection of the appropriate man-hour prediction equation.
Status	153 / 2	The whole numbers 1 or 2, with or without leading zeroes (all other values will cause records to be ignored)	The status identifies a job as being proposed or under construction. 1 = proposed 2 = under construction
Work Order Date	50 / 4*	mmyy, where mm is a two digit (0-9) number representing the month, and yy is a two digit (0-9) number representing the year	The work order date is used to estimate the start date which is the month work begins on a job. If this field contains invalid data, the let date will be used instead. *See Notes below.*
Let Date	46 / 4*	mmyy, see above	The let date is used to approximate the work order date if the work order date is invalid. It can be left blank for records containing a valid work order date.
Completion Date	58 / 4*	mmyy, see above	The completion date is the month when construction on a job is completed. This field can be blank or contain an invalid date (e.g. 0000). If so, the forecaster will estimate the completion date based on the job type and cost.
Job Cost	140 / 10	The digits (0-9)	This field contains the total cost of a job in whole dollars.

*These values can not be changed due to their data type.

Functional Classification

When developing the man-hour prediction equations, it became necessary to categorize jobs by their functional classification. A simple categorization was chosen based on the functional classification as shown in the following table:

Road Type	Functional Category	Functional Classification				
Interstates	INT	01	11	21	31	41
Other Freeways and Expressways	OFE	-	12	22	32	42
Other Principle Arterials	OPA	02	14	24	34	44
Minor Arterials	MIA	06	16	26	36	46
Collectors Streets	COL	-	17	27	37	47
Major Collectors	MAC	07	-	-	-	-
Minor Collectors	MIC	08	-	-	-	-
Local Roads	LOC	09	19	29	39	49

Notes on the input file format:

- If a job in a data set does not have a valid start date, the AHTD Man-Hour Forecaster cannot distribute its man-hours. The work order date is assumed to be the start date. If the work order date is invalid, the let date is used to estimate the start date. If both are invalid, the job will not be processed.

- The completion date is used to calculate the length (in months) of a job. If a job does not have a valid completion date (which is the case for most jobs in a typical data set), a completion date must be estimated by the AHTD Man-Hour forecaster (see Appendix C).